temperature of supply gas

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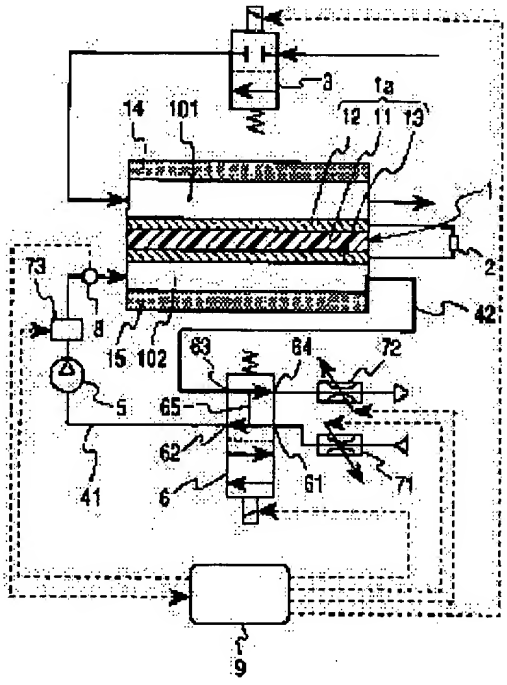
(54) WARMING-UP SYSTEM OF FUEL CELL

(57)Abstract:

PROBLEM TO BE SOLVED: To exert sufficient warming performance in a warming-up system of a fuel cell.

SOLUTION: This warming-up system is provided with an air pump 5 that compresses the air from an intake passage 41 into which an new air is sucked and feeds it to a fuel cell 1, a circulating passage 65 that branches from an exhaust passage 42 for releasing the air exhausted from the fuel cell 1 to join to the intake passage 41, and thus circulates the air from the fuel cell 1 to the air pump 5, and a switching valve 6 for switching the opening of. the circulating passage 65; and is so structured that the circulating passage 65 is opened by controlling the switch valve 6 with a control means 9 before feeding the fuel and the air, the air pump 5 is set to work and thereby, the fuel cell 1 is warmed by the circulated air that is compressed and heated when flowing through the circulating passage 65 and passing the air pump 5.



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CLAIMS

[Claim(s)]
[Claim 1] It is the warming-up system of a fuel cell which is equipped with the following, sets up the above-mentioned control means so that an air pump may be operated while they control a reflux way opening switch means in advance of supply of the fuel to a fuel cell and open a reflux way, and is characterized by carrying out warming up of the fuel cell by the recirculating air which circulates and carries out the temperature up of the reflux way at the time of air pump passage. The air pump which compresses the air from the inhalation-of-air passage where new mind is inhaled, and is supplied to a fuel cell The reflux way which it branches [way] from the exhaust air passage which emits outside the air discharged from a fuel cell, and the above-mentioned inhalation-of-air passage is joined [way], and makes the eccrisis air from a fuel cell flow back to an air pump The reflux way opening switch means which switches the opening of a reflux way Control means which control fuel and air supply
[Claim 2] In the warming-up system of a fuel cell according to claim 1 rather than a tee with the above-mentioned reflux way of the above-mentioned inhalation-of-air passage in the upper section The inhalation-of-air passage opening switch means which switches the opening of inhalation-of-air passage is established. rather than a tee with the above-mentioned reflux way of the above-mentioned exhaust air passage to a downstream It is the warming-up system of the fuel cell set up so that the exhaust air passage opening switch means which switches the opening of exhaust air passage might be established, the above-mentioned control means might control an inhalation-of-air passage opening switch means and an exhaust air passage opening change means in advance of supply of the fuel to a fuel cell and inhalation-of-air passage and exhaust air passage might be closed.
[Claim 3] It is the warming-up system of the fuel cell which was made to possess a claim 1 or the temperature sensor which detects [in / the warming-up system of the fuel cell of a publication / 2 either] the temperature of the above-mentioned fuel cell, and was set up so that supply of fuel might be started, if the above-mentioned control means exceeded the power generation start reference temperature which detection temperature set up beforehand.
[Claim 4] The warming-up system of the fuel cell set up so that it might become reference temperature in the warming-up system of a fuel cell according to claim 3 at the time of the stationary by which detection temperature set up the above-mentioned control means beforehand during the power generation operation and the opening of the above-mentioned reflux way might be switched.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the warming-up system of a fuel cell.
[0002]
[Description of the Prior Art] In recent years, in the field of an automobile, the electric vehicle attracts attention from the consideration to environment, especially the atmosphere, and if it is in the electric vehicle which carried the battery as a power supply, it already goes into the stage of utilization. However, since it has the problem difficult for solution with the charging time a battery formula electric vehicle has comparatively short mileage at a relation with accumulation-of-electricity capacity, and long, as an electric vehicle which can cancel this, it replaces with a battery and waits for the utilization of a fuel cell formula electric vehicle which carried the fuel cell generated by the electrochemical oxidation-reduction reaction of fuel, such as hydrogen, and oxidizing gases, such as oxygen.
[0003] It has the property that the capacity of a fuel cell which a low and an electrochemical oxidation-reduction reaction are not efficiently performed, and temperature is not fully generated, and carries out warming up by self since an energy conversion efficiency, i.e., a generating efficiency, is high and there is little generation of heat by the power generation loss is small. For this property, in the during starting, especially the cold machine state of a fuel cell, the reaction of fuel and oxygen was not actively carried out for the temperature of a fuel cell to a low sake, but the hydrogen of non-** was discharged and there was a problem that it was difficult to obtain the power of vehicles enough immediately after starting.
[0004] In JP,7-94202,A, an electric heater is prepared in the storage-of-water tank which the cooling water of the cooling system of a fuel cell can collect, cooling water is heated by energizing from a battery or a fuel cell to this at an electric heater, and the warming-up system of the fuel cell which was made to perform warming up of a fuel cell is proposed.
[0005]
[Problem(s) to be Solved by the Invention] However, in a warming-up system given [above-mentioned] in JP,7-94202,A, in order to use cooling water as a working fluid which conveys heat, there is the following problem. That is, a lot of [the big heat capacity for securing required refrigeration capacity / required] cooling water on the above-mentioned storage-of-water tank can collect the cooling water which circulates through a cooling system. For this reason, when huge heater power will be consumed, unless it uses the big thing of heater capacity, warming up does not take time or warming up of the outside air temperature cannot fully be carried out at the time of a low.
[0006] this invention was made in view of the above-mentioned actual condition, demonstrates sufficient warming-up performance, and aims at moreover proposing fuel cell warming-up JISUTEMU with little power consumption.
[0007]
[Means for Solving the Problem] The air pump which a warming-up system compresses the air from the inhalation-of-air passage where new mind is inhaled in invention according to claim 1, and is supplied to a fuel cell, The reflux way which it branches [way] from the exhaust air passage which emits outside the air discharged from a fuel cell, and the above-mentioned inhalation-of-air passage is joined [way], and makes the eccrisis air from a fuel cell flow back to an air pump, The reflux way opening switch means which switches the opening of a reflux way, and the control means which control fuel and air supply are made to provide. The above-mentioned control means are set up so that an air pump may be operated while they control a reflux way opening switch means in advance of supply of the fuel to a fuel cell and open a reflux way, and they carry out warming up of the fuel cell by the recirculating air which circulates and carries out the compression temperature up of the reflux way at the time of air pump passage.
[0008] The total heat capacity of the air which circulates the circuit formed of a reflux way is farther [than the cooling water of a fuel cell] small. Without carrying out a deer and supplying huge power to an electric heater etc. in this invention, a temperature up is carried out promptly, a heat exchange is efficiently made in a fuel cell, and the air with which warming up of a fuel cell is presented can fully perform warming up of a fuel cell.
[0009] In invention according to claim 2, rather than a tee with the above-mentioned reflux way of inhalation-of-air passage, in the upper section The inhalation-of-air passage opening switch means which switches the opening of inhalation-of-air passage is established. rather than a tee with the above-mentioned reflux way of exhaust air passage to a downstream In advance of supply of the fuel to a fuel cell, the exhaust air passage opening switch means which switches the opening of exhaust air passage is established, and the above-mentioned control means control an inhalation-of-air passage opening switch means and an exhaust air passage opening switch means, and they are set up so that inhalation-of-air passage and exhaust air passage may be closed.
[0010] By closing inhalation-of-air passage and exhaust air passage in warming up before a power generation operation, only a recirculating air is supplied to a fuel cell as an object for warming up, and can carry out warming up of the fuel cell still more efficiently.
[0011] In invention according to claim 3, the temperature sensor which detects the temperature of the above-mentioned fuel cell is made to provide, and if detection temperature exceeds the power generation start reference temperature set up beforehand, the above-mentioned control means will be set up so that supply of the fuel to a fuel cell may be started.
[0012] It can judge whether warming up of a fuel cell was fully made from detection temperature, and as soon as warming up should fully do, it can shift to a power generation operation promptly.
[0013] In invention according to claim 4, it sets up so that it may become reference temperature at the time of the stationary by which detection temperature set up the above-mentioned control means beforehand during the power generation operation and the opening of the

above-mentioned reflux way may be switched.
[0014] The amount of reflux to the fuel cell of the eccrisis air from a fuel cell with temperature higher than new mind can be adjusted by switch of reflux way opening, even when outside air temperature is low and fuel cell temperature falls during a power generation operation, fuel cell temperature can be maintained, and decline in a generating efficiency can be prevented.
[0015]
[Embodiments of the Invention] (The 1st operation gestalt) The 1st operation gestalt of the warming-up system of the fuel cell of this invention is shown in drawing 1 . For cell 1a of a fuel cell 1 to stick a fuel electrode 12 to one field of an electrolyte plate 11, makes it come to stick an air pole 13 to the field of another side, and the separator 14 and 15 which fabricated carbon etc. to the tabular is pinching this cell 1a. Of the crevice formed in the field by the side of the fuel electrode 12 of separator 14 and 15, or an air pole 13, a combustion chamber 101 is formed by making the separator 14 and fuel electrode 12 by the side of a fuel electrode 12 into an interior wall side, and the air chamber 102 which makes the separator 15 and air pole 13 by the side of an air pole 13 an interior wall side is formed.
[0016] It switches to a combustion chamber 101, the hydrogen which is fuel is introduced through a bulb 3, and air is introduced into an air chamber 102 from an air pump 5. The air from the inhalation-of-air passage 41 where new mind is inhaled is taken in by the air pump 5. It supplies in a fuel cell 1 in the clean state where the electric rotary pump of the general oil free type as an object for the air supply to a fuel cell is used, compress and breathe out the taken-in air in an air pump 5, and foreign matters, such as oil, are not included in it. And voltage occurs between a fuel electrode 12 and an air pole 13 by the electrochemical oxidation-reduction reaction of the hydrogen in each of a fuel electrode 12 and an air pole 13, and the oxygen in air, and electric power is supplied to a load 2. Moreover, the exhaust air passage 42 is connected to an air chamber 102, and the generation gas of the above-mentioned electrochemical oxidation-reduction reaction is emitted outside.
[0017] A warming-up system is constituted including the attachment object of the fundamental fuel cell 1 of the above-mentioned air pump 5 or inhalation-of-air passage 41 grade. The diverter valve 6 is formed in the middle of the inhalation-of-air passage 41 and the exhaust air passage 42. the diverter valve 6 for these air -- the upper section of the inhalation-of-air passage 41, and a downstream -- respectively -- ** -- two ports 61 and 62 for inhalation-of-air passage open for free passage, the upper section of the exhaust air passage 42, and a downstream -- respectively -- ** -- it has two ports 63 and 64 for exhaust air passage open for free passage, and the switch in the two state of standby and a normal state is enabled if the switch state of this diverter valve 6 is explained -- both states -- also in any, the upper section and the downstream of the inhalation-of-air passage 41 are open for free passage, and the upper section and the downstream of the exhaust air passage 42 are open for free passage And in standby (state of drawing), the inhalation-of-air passage 41 and the exhaust air passage 42 are open for free passage with the reflux way 65 formed in the diverter-valve 6 interior, and the inhalation-of-air passage 41 and the exhaust air passage 42 are intercepted in a normal state. That is, a diverter valve 6 opens and closes the reflux way 65 which connects the inhalation-of-air passage 41 and the exhaust air passage 42.
[0018] In the inhalation-of-air passage 41, the throttle valve 71 is formed in the upstream of the diverter valve 6 for air, and adjustment of the opening of the inhalation-of-air passage 41 is enabled. Moreover, the throttle valve 72 is formed in the lower stream of a river of a diverter valve 6, and adjustment of the opening of the exhaust air passage 42 is enabled in the exhaust air passage 42.
[0019] The control unit 9 which performs control of an air pump 5, diverter valves 3 and 6, and throttle valves 71 and 72 is formed, and warming up of starting of a fuel cell 1 and a halt, and a fuel cell 1 is performed. A control unit 9 consists of microcomputers etc.
[0020] Moreover, the temperature sensor 8 is formed near the entrance of the air chamber 102 of the fuel cell 1 which is the lowest style section of the inhalation-of-air passage 41, the temperature of the air which flows into an air chamber 102 is detected, and a detecting signal inputs into a control unit 9. Although the detection temperature by the temperature sensor 8 is the temperature near the air chamber 102 entrance of a fuel cell 1, since it is far thin, as compared with the separator 14 and 15 with which an electrolyte plate 11, a fuel electrode 12, and an air pole 13 pinch these mechanically, heat capacity is small, heat conduction of an air pole 13 is also good, and detection temperature follows in footsteps of temperature of cell 1a with sufficient responsibility as compared with the case where a temperature sensor is prepared in separator 14 and 15. Thus, the temperature of cell 1a is substantially detectable with the temperature sensor 8 prepared in the lowest style section of the inhalation-of-air passage 41. Between the air pump 5 and the temperature sensor 8, the humidifier 73 which humidifies the air breathed out from this pump 5 is arranged. This humidifier 73 is controlled by the control unit 9, and when the temperature of the air breathed out from the pump 5 reaches a predetermined value (when it is no longer low-temperature during starting), the water of the amount beforehand defined by the signal from a control unit 9 is supplied to air from a humidifier 73. Thereby, the air breathed out from the pump 5 is humidified. As a reason for humidifying air, cell 1a of a fuel cell 1 is for a poly membrane not to function as an ionic conductor, if it consists of poly membranes of ion conductivity and moisture is not contained in this poly membrane. In addition, when the temperature of the air breathed out from the pump 5 is less than a predetermined value, the water from a humidifier 73 is not supplied for suppressing that the temperature of air falls and a warming-up facilitatory effect falls.
[0021] The timing diagram which shows the operation of each part of a system from starting of this warming-up system to power generation to drawing 2 is shown. (B) is the opening of throttle valves 71 and 72, (A) is the detection temperature of a temperature sensor 8, and (D) is [(C) is an air content which is breathed out from an air pump 5 and supplied to a fuel cell 1, and] the amount of hydrogen supplied to a fuel cell 1. The operation of this warming-up system is explained with the control procedure performed in a control unit 9 by this and above-mentioned drawing 1 . Before a control unit 9 makes the diverter valve 3 for fuel "open", it precedes starting supply of hydrogen to a fuel cell 1, and performs warming up of a fuel cell 1 to the during starting of a fuel cell 1 as follows in the state (state of drawing 1) where it considered as "close." First, both the throttle valves 71 and 72 are made into a close by-pass bulb completely, and the inhalation-of-air passage 41 and the exhaust air passage 42 set the diverter valve 6 for air as the state of drawing 1 of connecting through the reflux way 65. And an air pump 5 is started in this state. The air breathed out from the air pump 5 circulates through the circuit which results in the downstream of the upper section of a fuel cell 1 - the exhaust air passage 42 a diverter valve 6 - the inhalation-of-air passage 41, and returns to an air pump 5. In addition, the driver voltage to an air pump 5 is set up so that it may operate in the rotation region where theoretical efficiency serves as the highest, and the inside of the air chamber 102 of a fuel cell 1 is made for the air of a peak to circulate.
[0022] An air pump 5 generates heat with compression loss and mechanical loss at the time of an operation, and especially generates the heat of a considerable amount in the thing of an oil free type. A deer is carried out, the temperature up of the air is carried out at the time of air pump 5 passage, and, subsequently to cell 1a of a fuel cell 1, heat is radiated by the air pole 13. Here, since the air of a peak circulates like the above in an air chamber 102, the rate of flow of the air in an air chamber 102 is very quick, and the heat exchange between air and cell 1a is performed efficiently. And since the above-mentioned circuit where air circulates forms the closed loop, it does not have exchange of air, and there is no portion of a tank etc. which enlarges heat capacity all over a circuit. And the air which is a working fluid

has the small specific heat as compared with water. Thus, since the heat capacity of the air which exists in a circuit is small, the temperature up of the recirculating air is carried out to near the 100 degreeC in an instant.
[0023] If detection temperature becomes near the 100 degreeC which is the power generation start reference temperature set up beforehand, both the throttle valves 71 and 72 will be opened wide gradually, the rate of the amount of the air which performs inhalation of new mind and eccrisis to the fuel cell 1 exterior of eccrisis air little by little, and circulates through them will be reduced, and throttle valves 71 and 72 are considered as full open at the last. And the driver voltage of an air pump 5 is lowered, an air content is reduced, and it prepares for a power generation operation. In addition, control of these air pump 5 grade is performed so that detection temperature may rise towards the above-mentioned power generation start reference temperature.
[0024] And if detection temperature reaches power generation start reference temperature, hydrogen will be supplied to the combustion chamber 101 of a fuel cell 1 by making the diverter valve 3 for fuel "open", and power generation will be started.
[0025] If the temperature of the air breathed out from an air pump 5 rises and detection temperature reaches reference temperature at the time of a stationary after starting a power generation operation, the diverter valve 6 for air will be switched to a normal-state side, and the inhalation-of-air passage 41 and the exhaust air passage 42 will be intercepted, and let all the supply airs from an air pump 5 to a fuel cell 1 be the new mind inhaled from the best style section of the inhalation-of-air passage 41.
[0026] In addition, when outside air temperature is extremely low and detection temperature does not reach reference temperature in a cold district etc. at the time of a stationary, suppose the diverter valve 6 for air that the standby side 65, i.e., a reflux way, has been opened, the hot air which flows back from the exhaust air passage 42 to the supply air to a fuel cell 1 is made to mix, and it is made for the temperature of the air which flows into a fuel cell 1 to turn into reference temperature at the time of a stationary. Thereby, decline in the generating efficiency by the fall of cell 1a temperature can be prevented, and the supply voltage to a load 2 can be secured.
[0027] (The 2nd operation gestalt) The 2nd operation gestalt of the warming-up system of this invention is shown in drawing 3 . In the composition of drawing 1 , the composition for making air flow back from the exhaust air passage 42 to the inhalation-of-air passage 41 is replaced with another composition, and among drawing, since the same operation is substantially carried out about the portion which attached the same number as drawing 1 , it explains focusing on difference with the warming-up system of the composition of drawing 1 . The end connected in the downstream of the inhalation-of-air passage 41 and the throttle valve 71 for inhalation of air, and the other end has connected throttle valve 6A in the upper section of the exhaust air passage 42 and the throttle valve 72 for exhaust air. Throttle valve 6A for this reflux was constituted possible [opening adjustment], and opening is adjusted by the control unit 9.
[0028] By considering throttle valve 6A as full open, a control unit 9 makes the eccrisis air from a fuel cell 1 flow back to an air pump 5 through the inhalation-of-air passage 41 like [at the time of making a diverter valve 6 (drawing 1) into standby in the 1st operation gestalt], and can intercept the inhalation-of-air passage 41 and the exhaust air passage 42 like [at the time of making a diverter valve 6 into a normal state] by making throttle valve 6A into a close by-pass bulb completely. Furthermore, it is controlling to close making small gradually opening of throttle valve 6A which is a reflux way, after considering the throttle valve 71 for inhalation of air, and the throttle valve 72 for exhaust air as full open, since throttle valve 6A's can change opening continuously from a close by-pass bulb completely to full open, and the detection temperature by the temperature sensor 8 can turn into temperature smoothly at the time of a stationary.
[0029] In addition, the warming-up structure of a system cannot be limited to each above-mentioned operation gestalt, unless it is contrary to the meaning of this invention, it is arbitration, for example, it can be replaced with the throttle valve of inhalation passage and exhaust air passage, and also let it be the simple opening-and-closing valve closed at the time of warming up before a fuel-supply start. Moreover, it omits, new mind and the reflux air for warming up are mixed, and you may make it these throttle valves and opening-and-closing valves flow into a fuel cell depending on the demand to the standup of warming up.
[0030] Moreover, what is necessary is to ask for the relation of the air temperature and cell temperature in the lowest style section of inhalation-of-air passage in the experiment beforehand, and just to input into the control unit by using the result as a map, when the correspondence relation of the detection temperature of a temperature sensor and cell temperature which were prepared in inhalation-of-air passage when the capacity of a fuel cell was large and the number of cells also had it is not enough. [much] Moreover, as long as it is not necessary to know correctly whether warming up is enough, a temperature sensor may be omitted, for example, may set up a warming-up period with a timer simply.

[Translation done.]